ELECTROLUMINESCENT ELEMENT

BACKGROUND OF THE INVENTION

1. Field of the Invention

The present invention relates to an electroluminescent element used for illumination of a display unit, a controlling unit or the like of various electronic devices.

2. Background Art

Recently, in various electronic devices particularly portable terminal devices such as portable telephones, an electroluminescent element (EL element) has emitted lights by using a small IC-drive inverter or the like so that a display unit such as an LCD or a controlling unit such as a push button is illuminated for recognition or operation in a dark place.

According to the conventional EL element, a shield plate is formed at the EL element itself or between the EL element and a circuit of the device, and connected with a ground terminal (or an earth terminal) to prevent electromagnetic noise which is generated from the inverter or the like and causes incorrect operation of the device (for example, see Japanese Patent Unexamined Publication H09-283278).

The conventional EL element is described hereinafter with reference to Fig. 6.

Fig. 6 is a sectional perspective view of the conventional EL element. Various layers are deposited on an upper surface of light-transmitting substrate 1 such as a film so as to form the EL element. In Fig. 6, light-transmitting electrode layer 4 made of indium-tin oxide (referred to as "In-Tin Oxide" or

"ITO") or the like is formed on the upper surface of substrate 1 by using a sputtering method, an electron beam method or the like. Bus electrode 2 is formed on the upper surface of substrate 1 so as to be connected with light-transmitting electrode layer 4, and electrode terminal 2A extends from bus electrode 2 to tail portion 3.

Light emitting layer 5, dielectric layer 6 and backside electrode layer 7 are printed on light-transmitting electrode layer 4 in this order sequentially, and covered with insulating layer 8. Phosphors such as zinc sulfide (ZnS) or the like, which are base materials of luminousness, are dispersed in synthetic resin, thereby forming light emitting layer 5. Ferroelectric materials such as barium titanate ($TiBa_3$) or the like are dispersed in synthetic resin, thereby forming dielectric layer 6. Backside electrode layer 7 is formed of an electric conductor such as silver or carbon resin.

In addition, shielding layer 9 made of an electric conductor such as silver or carbon resin is printed on insulating layer 8. Electrode terminal 7A of backside electrode layer 7 and electrode terminal 9A of shielding layer 9 extend to tail portion 3, so that the EL element is constructed.

The EL element discussed above is placed at the back of the LCD, the push button or the like, and mounted at the electronic device. Electrode terminal 2A of bus electrode 2, electrode terminal 7A and electrode terminal 9A, all of which are formed on tail portion 3, are connected with the IC-drive inverter (not shown) or the like of an electronic circuit provided at the device by using a connector or the like.

AC voltage is supplied from the inverter or the like at the device, and applied from electrode terminal 2A and electrode terminal 7A to light-transmitting electrode layer 4, which is connected to bus electrode 2, and backside electrode layer 7. Then phosphors in light emitting layer 5 emit

lights and illuminate the display unit or the controlling unit of the electronic device from its back, so that the display unit or the controlling unit can be recognized even in a dark place.

Electrode terminal 9A is constructed to prevent electromagnetic noise generated from the inverter or the like for driving the EL element by using shielding layer 9 which is connected with the ground terminal of the electronic device, so that the incorrect operation of the device is prevented.

However, according to the conventional EL element, three electrode terminals (i.e., electrode terminal 2A, electrode terminal 7A and electrode terminal 9A) have to be connected with the electronic circuit of the device, where electrode terminal 2A is connected with bus electrode 2 and light-transmitting electrode layer 4, electrode terminal 7A is connected with backside electrode layer 7 and electrode terminal 9A is connected with shielding layer 9. Therefore, tail portion 3 to which these three electrode terminals extend becomes large and a large connector for connecting thereof is required.

The present invention is directed to provide an EL element which is capable of reducing a size of the tail portion and easy to be connected with the device.

SUMMARY OF THE INVENTION

An EL element of the present invention includes the following components:

a) an outer connecting part,

b) a light-transmitting and insulating sheet type substrate,

c) a light-transmitting electrode layer formed on the substrate wholly or except the outer connecting part in a specific pattern,

d) a light emitting layer formed on the light-transmitting electrode layer

in a specific pattern,

e) a dielectric layer formed on the light emitting layer in a specific pattern,

f) a backside electrode layer formed on the dielectric layer in a specific pattern,

g) an insulating layer formed on the backside electrode layer and the light-transmitting electrode layer except the outer connecting part, and

h) a shielding layer formed on the insulating layer in a specific pattern.

The light-transmitting electrode layer or the backside electrode layer is coupled with the shielding layer.

A non-luminous part, where the light emitting layer, the dielectric layer and the backside electrode layer are not formed, is formed on a peripheral part of the substrate. A hole, which penetrates to the light-transmitting electrode layer, is formed at the insulating layer at the non-luminous part. A connecting portion is formed at the hole by using conductive material so as to couple the light-transmitting electrode layer with the shielding layer.

According to another structure of the present invention, a hole, which penetrates to the light-transmitting electrode layer, is formed at the insulating layer at a luminous part, where the light emitting layer, the dielectric layer and the backside electrode layer are formed. An inner periphery of the hole is covered with insulating material, and a connecting portion is formed at the hole by using conductive material so as to couple the light-transmitting electrode layer with the shielding layer.

According to still another structure of the present invention, a hole, which penetrates to the backside electrode layer, is formed at the insulating layer at the luminous part, where the light emitting layer, the dielectric layer and the backside electrode layer are formed. A connecting portion is formed at

the hole by using conductive material so as to couple the backside electrode layer with the shielding layer.

According to the present invention, the connecting portion may be formed by using substantially an identical conductive material to the shielding layer.

According to yet another structure of the present invention, the outer connecting part protrudes from the substrate, and electrode terminals extend from the light-transmitting electrode layer and the backside electrode layer to the outer connecting part.

Using the structure discussed above, only two electrode terminals extend from the light-transmitting electrode layer and the backside electrode layer to a tail portion (i.e., the outer connecting part). Therefore, the EL element which is capable of reducing a size of the tail portion and easy to be coupled with the device can be provided.

In addition, according to the EL element of the present invention, the second insulating layer covers an upper surface of the shielding layer. Using this structure, the second insulating layer acts as a protective film, so that the shielding layer is prevented from being damaged while the EL element is conveyed or mounted at an electronic device. Besides, electrical insulation against other electronic components in the electronic device can be secured.

As discussed above, the present invention provides the EL element which is capable of reducing a size of the tail portion and easy to be coupled with the device, where the tail portion acts as the outer connecting part to be coupled with the device.

BRIEF DESCRIPTION OF THE DRAWINGS

Fig. 1 is a sectional view of an EL element in accordance with an exemplary embodiment of the present invention.

Fig. 2 is a sectional perspective view of the EL element in accordance with the exemplary embodiment of the present invention.

Fig. 3 is a sectional view of another EL element in accordance with the exemplary embodiment of the present invention.

Fig. 4 is a sectional view of still another EL element in accordance with the exemplary embodiment of the present invention.

Fig. 5 is a sectional perspective view of the still another EL element in accordance with the exemplary embodiment of the present invention.

Fig. 6 is a sectional perspective view of a conventional EL element.

DETAILED DESCRIPTION OF THE INVENTION

Exemplary embodiments of the present invention are demonstrated hereinafter with reference to the accompanying drawings.

In these drawings, the elements similar to those described in the Background Art have the same reference marks, and the descriptions of those elements are omitted here.

EXEMPLARY EMBODIMENT

Fig. 1 is a sectional view of an EL element in accordance with an exemplary embodiment of the present invention. Fig. 2 is a perspective sectional view of the EL element in accordance with the exemplary embodiment of the present invention.

In the present invention, various layers are formed on an upper surface of light-transmitting substrate 1 so as to construct the EL element. As shown in Figs. 1 and 2, light-transmitting electrode layer 4 is formed on the upper surface of substrate 1. Substrate 1 made of light-transmitting insulating material has a substantially rectangular shape as a main part, and has a tail

portion which acts as an outer connecting part. Substrate 1 is formed of a thin glass sheet or a resinous film such as polyethylene-terephthalate (PET). Light-transmitting electrode layer 4 is formed on substrate 1 wholly or in a specific pattern by depositing indium-tin oxide (ITO) using a sputtering method, an electron beam method or the like, or by printing using paste made of conductive resin such as polyethylene-dihydroxy-thiophene.

Bus electrode 2 is formed on an upper surface of rectangular substrate 1 so as to be adjacent to and parallel to one side of substrate 1. In addition, bus electrode 2, which is made of conductive material having low resistance, is connected with light-transmitting electrode layer 4. Electrode terminal 2A extends from bus electrode 2 to tail portion 10 which is on the same plane with substrate 1, protruded from a part of substrate 1 and acts as the outer connecting part.

Light emitting layer 5, dielectric layer 6 and backside electrode layer 7 are applied on light-transmitting electrode layer 4 in a specific pattern in this order sequentially, and covered with insulating layer 11. Phosphors such as zinc sulfide (ZnS) or the like, which are base materials of luminousness, are dispersed in synthetic resin such as fluorine rubber, thereby forming light emitting layer 5. Ferroelectric materials such as barium titanate ($TiBa_3$) or the like are dispersed in synthetic resin, thereby forming dielectric layer 6. Backside electrode layer 7 is formed by dispersing electric conductors such as silver or carbon in resin. Insulating layer 11 such as epoxy resin or polyester resin covers these layers mentioned above except tail portion 10 which acts as the outer connecting part. Insulating layer 11 has a hole, which penetrates to light-transmitting electrode layer 4, over a part of bus electrode 2. Electrode terminal 7A extends parallel with electrode terminal 2A from backside electrode layer 7 to tail portion 10 which acts as the outer connecting part.

Shielding layer 12 where electric conductors such as silver or carbon are dispersed in resin is formed on insulating layer 11. By forming shielding layer 12, connecting portion 13, where electric conductors such as silver or carbon are dispersed in resin, is formed at the hole. As discussed above, the hole has been formed at a peripheral part of insulating layer 11 and over the part of bus electrode 2 which is adjacent to and parallel to one side of substrate 1. As a result, shielding layer 12, which is formed on insulating layer 11, is coupled with light-transmitting electrode layer 4 via connecting portion 13. In other words, shielding layer 12 is coupled (hereinafter referred to as "through-hole coupled") with bus electrode 2 connected with light-transmitting electrode layer 4. Second insulating layer 14 such as epoxy resin or polyester resin covers shielding layer 12 except tail portion 10, so that the EL element of the present invention is constructed.

As discussed above, according to the EL element of the present invention, shielding layer 12 is coupled with bus electrode 2 via connecting portion 13, so that only two electrode terminals (i.e., electrode terminal 2A coupled with bus electrode 2 and electrode terminal 7A) extend to tail portion 10 which acts as the outer connecting part.

According to the embodiment mentioned above, the hole, which penetrates to light-transmitting electrode layer 4, is formed over bus electrode 2 so as to form connecting portion 13. However, the present invention is not limited to the EL element mentioned above. The significant feature of the present invention is that the hole for forming connecting portion 13 is formed at insulating layer 11 at a non-luminous part, where light emitting layer 5, dielectric layer 6 and backside electrode layer 7 are not formed, of a peripheral part of substrate 1. In addition, the hole penetrates to light-transmitting electrode layer 4.

Besides, according to the embodiment mentioned above, substrate 1 has a substantially rectangular shape as a main part, however, the EL element of the present invention is not limited to this shape, and other shapes or structures may be used as substrate 1.

The EL element discussed above is placed at the back of an LCD, a push button or the like, and mounted at an electronic device. Electrode terminal 2A of bus electrode 2 and electrode terminal 7A, both of which are formed at tail portion 10, are coupled with the IC-drive inverter (not shown) or the like of an electronic circuit provided at the device by using a connector or the like. Thus electrode terminal 2A is coupled with a ground terminal, and electrode terminal 7A is coupled with a power source terminal.

AC voltage is supplied from the inverter or the like at the device, and applied from electrode terminal 2A and electrode terminal 7A to light-transmitting electrode layer 4, which is coupled with bus electrode 2, and backside electrode layer 7. Then phosphors in light emitting layer 5 emit lights and illuminate a display unit or a controlling unit of the electronic device from its back, so that the display unit or the controlling unit can be recognized even in a dark place.

In addition, shielding layer 12 is coupled with bus electrode 2 via connecting portion 13, thereby being electrically coupled with the ground terminal of the device. By using shielding layer 12, electromagnet noise generated from the inverter or the like for driving the EL element is prevented, so that incorrect operation of the device is prevented.

As discussed above, according to the present invention, light-transmitting electrode layer 4 and shielding layer 12 are through-hole coupled with each other via connecting portion 13, where electric conductors such as silver or carbon are dispersed in the resin, at the hole of insulating

layer 11. Therefore, only two electrode terminals (i.e., electrode terminal 2A for being coupled with light-transmitting electrode layer 4 and electrode terminal 7A for being coupled with backside electrode layer 7) extend to tail portion 10 which acts as the outer connecting part. As a result, the EL element which is capable of reducing a size of the tail portion and easy to be coupled with the device can be obtained.

In addition, according to the EL element of the present invention, second insulating layer 14 covers an upper surface of shielding layer 12, so that second insulating layer 14 acts as a protective film for preventing shielding layer 12 from being damaged, while the EL element is conveyed or mounted at the electronic device. Besides, by using second insulating layer 14, electrical insulation against other electronic components in the electronic device can be secured.

As discussed above, according to the present invention, the hole is formed at a peripheral part of insulating layer 11. In addition, connecting portion 13, where electric conductors such as silver or carbon are dispersed in the resin, is formed at the hole so as to through-hole couple light-transmitting electrode layer 4 (or bus electrode 2) with shielding layer 12.

However, the present invention is not limited to the structure mentioned above, and other structures may be used. For example, as shown in Fig. 3 (i.e., a sectional view of another EL element in accordance with the exemplary embodiment of the present invention), a hole may be formed at insulating layer 11 so as to penetrate to light emitting layer 5, dielectric layer 6 and backside electrode layer 7. Then an inner periphery of the hole may be covered with insulating material which is substantially the same material as insulating layer 11. After that, connecting portion 13A, where electric conductors such as silver or carbon are dispersed in resin, may be formed at the hole, so that

light-transmitting electrode layer 4 and shielding layer 12 can be coupled with each other.

In addition, according to the present embodiment, light-transmitting electrode layer 4 (or bus electrode 2) and shielding layer 12,which is connected with layer 4 via connecting portion 13 (or connecting portion 13A), are electrically coupled with the ground terminal of the device, and backside electrode layer 7 is coupled with the power source terminal. However, conversely, backside electrode layer 7 may be electrically coupled with the ground terminal, and light-transmitting electrode layer 4 may be electrically coupled with the power source terminal. In this case, as shown in Fig. 4 (i.e., a sectional view of still another EL element in accordance with the exemplary embodiment of the present invention), the hole may be formed at insulating layer 11, and connecting portion 13, where electric conductors such as silver or carbon are dispersed in resin, may be formed at the hole, so that shielding layer 12 and backside electrode layer 7 may be coupled with each other.

Besides, according to the EL element of the present embodiment, bus electrode 2 is formed on the upper surface of rectangular substrate 1 so as to be adjacent to and parallel to one side of substrate 1. In addition, bus electrode 2, which is made of conductive material, is connected with light-transmitting electrode layer 4. Electrode terminal 2A extends from bus electrode 2 to tail portion 10 which acts as the outer connecting part.

However, as shown in Fig. 5 (i.e., a sectional perspective view of the still another EL element in accordance with the exemplary embodiment of the present invention), still another structure may be used. Bus electrode 2 may not be formed by selecting light-transmitting material used as light-transmitting electrode layer 4 formed on substrate 1. In other words, electrode terminal 2A coupled with light-transmitting electrode layer 4 may

extend to tail portion 10, which acts as the outer connecting part, without forming bus electrode 2. In this case, the hole may be formed at a peripheral part of insulating layer 11. For through-hole coupling light-transmitting electrode layer 4 with shielding layer 12 at the hole, connecting portion 13, where electric conductors such as silver or carbon are dispersed in resin, may be formed at a position near tail portion 10, which acts as the outer connecting part. Light-transmitting electrode layer 4 and electrode terminal 2A are coupled with each other at the position. According to the structure discussed above, bus electrode 2 is not necessary. Therefore, when the EL element has the same substrate size as a conventional one, an area of a luminous part can be enlarged. When the EL element has the same area of a luminous part as the conventional one, the size of the substrate or the EL element can be reduced.

As discussed above, the present invention provides the EL element which is capable of reducing the size of the tail portion and easy to be coupled with the device, where the tail portion acts as the outer connecting part to be coupled with the device. Therefore, the EL element of the present invention can be applied at various electronic devices such as portable terminal devices.